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	Excess of Computed R.A. s	No. of Obs.
1851	−0·07	5
1852	−0·06	4
1855	−0·00	5
1858	+0·01	6
1861	+0·05	2
1862	+0·06	3
1863	+0·03	3
1865	+0·01	3
1866	+0·02	1
1867	+0·03	3

The evidence in favour of the supposed variability of the proper motion in Right Ascension appears to me but very slight indeed.

1876, *Jan.* 20.

On the Proper Motions of the Two Components of the Binary System α Centauri.

By E. J. Stone, Esq., F.R.S., Her Majesty's Astronomer, Cape of Good Hope.

In the formation of the Cape General Catalogue of Stars for 1860, I adopted $-0^{\mathrm{s}}{\cdot}470$ and $-0''{\cdot}83$ for the *common* proper motions of the stars α_1 and α_2 *Centauri* in R.A. and N.P.D. respectively. In the Melbourne General Catalogue of Stars for 1870, the adopted *common* proper motions are $-0^{\mathrm{s}}{\cdot}480$ and $-0''{\cdot}49$. Attention has been called to the discrepancy between these adopted values, particularly in N.P.D., in *Nature* of 1874, November 4. The writer appears to consider the Melbourne value the more correct, and that the Cape value depends upon Lacaille's declination. The point here raised is of some importance. I have, therefore, collected together the data available to me, and discussed them in the present paper.

The following observations will be made use of:—

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α Centauri.

(1st magnitude).

	Epoch.	R.A.			No. of Obs.	N.P.D.			No. of Obs.
		h	m	s		°	′	″	
1	1750	14	22	49·9		149	47	8	
2	1825	14	27	(46·77)		150	6	19·1	171
3	1830 F	14	28	7·47	11	150	7	32·68	8
4	1830 J	14	28	7·98	21	150	7	35·40	13
5	1833	14	28	19·74	27	150	8	20·9	20
6	1840	14	28	47·45	189	150	10	7·10	47
7	1860	14	30	7·23	2	150	15	19·55	160
8	1870	14	30	47·07	20	150	17	53·93	20
9	1871					150	18	9·72	32
10	1872					150	18	24·64	3
11	1875	14	31	7·07	4				

α Centauri.

(2·3 magnitude.)

	Epoch.	R.A.			No. of Obs.	N.P.D.			No. of Obs.
		h	m	s		°	′	″	
1	1750	14	22	48·2		149	47	24	
2	1825	14	27	(45·04)		150	6	37·4	44
3	1830 F								
4	1830 J	14	28	6·44	7	150	7	51·8	7
5	1833	14	28	18·22	26	150	8	35·5	17
6	1840	14	28	46·09	180	150	10	20·78	33
7	1860	14	30	7·06	3	150	15	18·68	3
8	1870	14	30	47·50	10	150	17	43·69	13
9	1871					150	18	0·11	29
10	1872					150	18	15·38	3
11	1875	14	31	7·70	4				

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The observations in the first group are Lacaille's; the second contains Brisbane's Observations; the fourth, Johnson's St. Helena Observations. The observations in the eighth group are taken from the Melbourne Catalogue; the other observations are all Cape Observations. I have no confidence in Brisbane's Right Ascensions, and I have not used them in the present enquiry. Taylor's Catalogue is not available: the observations extend over many years, and the mean year of observation is not given in the Catalogue.

There are two ways in which these observations may be discussed with reference to the proper motions of the stars. If the stars are so far apart from each other that their common gravitation does not affect, by quantities yet observationally sensible, the proper motions existing at any epoch, there is no legitimate ground for an *à priori* assumption of any proper motion common to the stars. The proper motions of each star must be determined in the usual way, and applied to the reductions of the place of the star from one epoch to another. If on the other hand, we assume that the stars are so near to each other that the effects of their common gravitation are observationally sensible, we have no right to expect that the proper motions determined in the usual way for each star will be constant. The only legitimate assumption is, that the proper motion of their common centre of gravity may, from our experience in the case of other stars, be sensibly constant. I will discuss the observations on both assumptions.

The proper motions of the two stars in R.A. and N.P.D. will be represented by x_1, y_1, x_2, y_2. The true Right Ascensions and North Polar Distances for 1870 will be assumed to be:

h	m	s	°	′	″
14	30	$47{\cdot}07 + a_1$,	150	17	$53{\cdot}93 + d_1$
14	30	$47{\cdot}50 + a_2$,	150	17	$43{\cdot}69 + d_2$.

On account of the existence of systematic errors, some limit must be fixed to the weight which can be assigned to a group of observations. I have fixed upon 36 as the extreme weight. Up to that limit I roughly weight the residuals in proportion to the number of observations in each group. The following are the equations of condition for each star:—

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1st Magnitude Star.

Group.		R.A. s	$\sqrt{\omega}$	C.−O. s
1	$a_1 - 120\,x_1 =$	57·69	1	+2·48
3	$a_1 - 40\,x_1 =$	20·47	5	−0·30
4	$a_1 - 40\,x_1 =$	19·96	4	+0·21
5	$a_1 - 37\,x_1 =$	18·81	5	−0·14
6	$a_1 - 30\,x_1 =$	15·17	6	0·00
7	$a_1 - 10\,x_1 =$	5·17	1	0·00
8	$a_1 - 0\,x_1 =$	0·00	5	+0·17
11	$a_1 + 5\,x_1 =$	−2·53	2	+0·20

$$133\,a_1 - 3755\,x_1 = +1900{\cdot}22$$
$$-3755\,a_1 + 146825\,x_1 = -74052{\cdot}35$$
$$a_1 = +0^{s}{\cdot}172, \quad x_1 = -0^{s}{\cdot}500.$$

2·3 Magnitude Star.

		R.A. s	$\sqrt{\omega}$	C.−O. s
1	$a_2 - 120\,x_2 =$	55·56	1	−0·64
4	$a_2 - 40\,x_2 =$	18·50	3	−0·30
5	$a_2 - 37\,x_2 =$	16·86	5	−0·04
6	$a_2 - 30\,x_2 =$	13·38	6	+0·23
7	$a_2 - 10\,x_2 =$	4·57	2	−0·14
8	$a_2 - 0\,x_2 =$	0·00	4	−0·16
11	$a_2 + 5\,x_2 =$	−2·33	2	−0·13

$$95\,a_2 - 2505\,x_2 = 1134{\cdot}20$$
$$-2505\,a_2 + 95925\,x_2 = -43602{\cdot}50$$
$$a_2 = -0^{s}{\cdot}164, \quad x_2 = -0^{s}{\cdot}459.$$

The following are the equations of condition in N.P.D. :—

1st Magnitude Star.

	N.P.D.	s	$\sqrt{\omega}$	C.−O.
1	$d_1 - 120\,y_1 =$	84·13	1	−23·67
2	$d_1 - 45\,y_1 =$	22·99	5	− 1·15
3	$d_1 - 40\,y_1 =$	19·17	4	+ 0·09
4	$d_1 - 40\,y_1 =$	16·39	3	+ 2·87
5	$d_1 - 37\,y_1 =$	16·65	4	+ 1·07
6	$d_1 - 30\,y_1 =$	10·91	5	+ 3·20
7	$d_1 - 10\,y_1 =$	4·50	1	− 0·69
8	$d_1 - 0\,y_1 =$	0·00	4	− 1·34
9	$d_1 + y_1 =$	−0·08	5	− 1·78
10	$d_1 + 2y_1 =$	−1·03	2	− 1·34

$$138\,d_1 - 3564\,y_1 = 1650{\cdot}64$$
$$-3564\,d_1 + 149570\,y_1 = -72223{\cdot}09$$
$$d_1 = -1''{\cdot}34, \quad y_1 = -0''{\cdot}515$$

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2·3 Magnitude Star.

		$\sqrt{\omega}$	C.−O.
1	$d_2 - 120\, y_2 = 110·37$	1	+ 19·42
2	$d_2 - 45\, y_2 = 51·53$	5	− 1·39
4	$d_2 - 40\, y_2 = 45·81$	3	− 0·98
5	$d_2 - 37\, y_2 = 41·49$	4	+ 0·15
6	$d_2 - 30\, y_2 = 34·83$	5	− 0·62
7	$d_2 - 10\, y_2 = 13·87$	2	− 0·90
8	$d_2 - 0\, y_2 = 0·00$	3	+ 2·35
9	$d_2 + y_2 = 0·55$	5	+ 0·74
10	$d_2 + 2\, y_2 = -0·05$	2	+ 0·28

$$118\, d_2 - 2954\, y_2 = 3414·53$$

$$-2954\, d_2 + 124270\, y_2 = 138933·28$$

$$d_2 = +2''·35, \quad y_2 = -1''·062$$

The values of the proper motions of the principal star agree closely with the adopted *common* proper motions of the Melbourne Catalogue. The means of the proper motions of the two stars agree closely with the adopted *common* proper motions of the Cape Catalogue.

If, for clearness of conception of the differences between these proper motions, especially in N.P.D., we place side by side the proper motions that would result from a comparison of the last group with each of the other groups whose epoch differs from its epoch by more than ten years, we have as follows:—

Proper Motions in N.P.D.

	1750.	1825.	1830.	1833.	1840.	1860.
	″	″	″	″	″	″
1 Mag *	−0·698	−0·511	−0·481 0·412	−0·453	−0·373	−0·461
2·3 Mag *	−0·905	−1·098	−1·092	−1·065	−1·090	−1·160
Mean P.M.	−0·802	−0·804	−0·770	−0·759	−0·732	−0·810

If therefore we attach the slightest weight to Lacaille's observations, the physical connexion of the two stars is at once established, and the course adopted in the Cape Catalogue is sensibly correct. But if this physical connexion is not admitted, the adoption of a common proper motion of − 0″·50 in N.P.D. for the two stars is certainly not satisfactory. The adopted proper motion should be − 0″·52 for the 1st magnitude star, and − 1″·06 for the 2·3 magnitude star. An inspection, however, of the residuals shows, I venture to think, that the assumption of a constant proper motion for either star is not a true assumption, and that the physical connexion of the system must be admitted.

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I therefore pass to the second assumption. If m_1 and m_2 denote the masses of the two stars, we may show that

$$\frac{m_1}{m_1+m_2}\,x_1 + \frac{m_2}{m_1+m_2}\,x^2 \text{ and } \frac{m_1}{m_1+m_2}\,y_1 + \frac{m_2}{m_1+m_2}\,y_2$$

are constant when terms of the second order are neglected. To the same order of approximation these expressions in fact denote the proper motions of the centre of gravity of the system in R.A. and N.P.D. If the data were sufficiently accurate and well distributed, it should be possible to infer the ratio of the masses $m_1 : m_2$ from the condition that this ratio rendered the proper motions of the centre of gravity constant. The data at present available are not perhaps sufficient for such a delicate inquiry, but it will be seen that an assumption of equality between the masses does render the proper motions of the centre of gravity very accordant. As this assumption appears to satisfy the conditions better than one dependent upon their brightness, I have provisionally adopted it.

Assuming therefore $m_1 = m_2$, and denoting the R.A. and N.P.D. of the centre of gravity at the epoch 1870 by

$$14^{\text{h}}\ 30^{\text{m}}\ 47^{\text{s}}{\cdot}285 + a$$
$$150^\circ\ 17'\ 48''{\cdot}81 + d$$

and the proper motions of the centre of gravity by x and y, we have the following equations of condition.

R.A. Observations.

Epoch.		$\sqrt{\omega}$	C.−O.
	s		s
1750	$a - 120\,x = 56{\cdot}63$	1	+0·56
1830	$a - 40\,x = 19{\cdot}49$	$\sqrt{5}$	−0·38
1833	$a - 37\,x = 17{\cdot}84$	$\sqrt{13}$	−0·16
1840	$a - 30\,x = 14{\cdot}28$	$\sqrt{36}$	+0·07
1860	$a - 10\,x = 4{\cdot}87$	1	−0·04
1870	$a - 0\,x = 0{\cdot}00$	$\sqrt{8}$	+0·07
1875	$a + 5\,x = -2{\cdot}43$	$\sqrt{2}$	+0·12

From which we derive the following equations for the determination of a and x:

$$66\,a - 1881\,x = 900{\cdot}09$$
$$-1881\,a + 72747\,x = -34770{\cdot}04;$$

which give:

$$a = +0^{\text{s}}{\cdot}072$$
$$x = -0^{\text{s}}{\cdot}476.$$

It is with these values that the residuals given in the column (C.−O.) have been formed.

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N.P.D. Observations.

Epoch.		″	$\sqrt{\omega}$	C.−O. ″
1750	$d - 120\,y$ =	97·25	1	−0·28
1825	$d - 45\,y$ =	37·26	6	−0·67
1830	$d - 40\,y$ =	32·49	2	+0·08
1833	$d - 37\,y$ =	29·07	3	+1·08
1840	$d - 30\,y$ =	22·88	4	+1·64
1860	$d - 10\,y$ =	9·19	2	−0·77
1870	$d - 0\,y$ =	0·00	3	+0·37
1871	$d + y$ =	0·24	4	−0·68
1872	$d + 2\,y$ =	−0·54	1	−0·70

The equations for the determination of d and y are:

$$96\,d - 2735\,y = 2236{\cdot}34$$
$$-2735\,d + 120841\,y = -98257{\cdot}15$$

which give:

$$d = +0''{\cdot}366$$
$$y = -0''{\cdot}805$$

These values have been used in the formation of the residual errors.

The residuals for the N.P.D. observations about 1833–1840 are large; but it may be mentioned that the observations in the groups 1833–1840 were made with the same instrument, and that, although the adopted zenith-points have been determined from reflexion and direct observations of stars, and that the observations of *α Centauri* must, from their number, have had considerable weight in the formation of the adopted zenith-points, yet a discordance of about 1″·6 still exists between the direct and reflexion results for *α Centauri*. The residuals are, however, certainly much more satisfactory, especially in N.P.D., than the residual errors resulting from the assumption of the independence of the two stars. It is not, therefore, the use of Lacaille's observations which give rise to the large proper motion in N.P.D. adopted in the Cape Catalogue, for but little weight has been assigned them. If we compare the last Cape observation group for 1872 with the earlier observations, the following would be the separate values of the common proper motion in N.P.D.:

1750.	1825.	1830.	1833.	1840.	1860.
−0″·801	−0·804	−0·786	−0·759	−0·732	+0·810

These results are as accordant as could be expected, and appear to justify as a close approximation to the truth the

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assumption of $m_1 = m_2$. It will be seen that the proper motions deduced from the centre of gravity of the system, or the common proper motions of the two stars, viz., $-0^{s}{\cdot}476$ and $-0''{\cdot}805$, are nearly the same as those adopted in the Cape Catalogue, 1860. If common proper motions be adopted for the two stars, the results of the Cape Catalogue are substantially correct.

Occultation of the Pleiades observed at Madras, on January 7th, 1876.

(*Communicated by N. R. Pogson, Esq., Director of the Observatory*).

Star.	Phenomenon.	Madras M.T.			Observer.
		h	m	s	
16 Tauri (Celæno)	Disap.	12	43	50·9	N. R. P.
„ „ „	„	12	43	51·0	E. I. P.
17 Tauri (Electra)	„	12	47	28·8	N. R. P.
„ „ „	„	12	47	29·1	E. I. P.
19 Tauri (Taygeta)	„	13	7	43·1	N. R. P.
„ „ „	„	13	7	43·1	E. I. P.
20 Tauri (Maia)	„	13	14	9·6	N. R. P.
„ „ „	„	13	14	18·0	E. I. P.
Bessel's Anonyma 8	„	13	23	1·1	N. R. P.
„ „ „	„	13	23	1·5	E. I. P.
Bessel's Anonyma 9	„	13	24	14·7	N. R. P.
Bessel's Anonyma 10	„	13	28	3·7	E. I. P.
22 Tauri	„	13	35	47·3	N. R. P.
„ „	„	13	35	47·0	E. I. P.
21 Tauri (Asterope)	„	13	40	27·1	N. R. P.
„ „ „	„	13	40	26·7	E. I. P.
Bessel's Anonyma 12	„	13	54	30·0	N. R. P.
„ „ „	„	13	54	32·5	E. I. P.
24 Tauri	„	13	58	49·2	N. R. P.
η Tauri (Alcyone)	„	14	3	48·3	N. R. P.
„ „ „	„	14	3	47·8	E. I. P.
20 Tauri (Maia)	Reap.	14	12	27·2	N. R. P.
„ „ „	„	14	12	32·4	E. I. P.
Bessel's Anonyma 29	Disap.	14	19	10·3	N. R. P.
η Tauri (Alcyone)	Reap.	14	38	24·3	N. R. P.
„ „ „	„	14	38	15·2	E. I. P.

The preceding Observations were made, as initialled, by Mr. Norman R. Pogson, with the Smythian 5-ft. telescope, by Tulley,

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